

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04N	A2	(11) International Publication Number: WO 97/22201 (43) International Publication Date: 19 June 1997 (19.06.97)
(21) International Application Number: PCT/US96/19226 (22) International Filing Date: 12 December 1996 (12.12.96) (30) Priority Data: 60/008,531 12 December 1995 (12.12.95) US (71)(72) Applicants and Inventors: CAMPBELL, Roy, H. [US/US]; University of Illinois at Champaign-Urbana, Dept. of Computer Science, 1304 W. Springfield, Urbana, IL 61801 (US). TAN, See-Mong [SG/US]; University of Illinois at Champaign-Urbana, Dept. of Computer Science, 1304 W. Springfield, Urbana, IL 61801 (US). XIE, Dong [CN/NO]; University of Illinois at Champaign-Urbana, Dept. of Computer Science, 1304 W. Springfield, Urbana, IL 61801 (US). CHEN, Zhigang [CN/US]; University of Illinois at Champaign-Urbana, Dept. of Computer Science, 1304 W. Springfield, Urbana, IL 61801 (US). (74) Agents: BERNSTEIN, Frank, L. et al.; Sughrue, Mion, Zinn, Macpeak & Seas, Suite 800, 2100 Pennsylvania Avenue, N.W., Washington, DC 20037-3202 (US).		(81) Designated States: CN, JP, KR, RU, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>Without international search report and to be republished upon receipt of that report.</i>
(54) Title: METHOD OF AND SYSTEM FOR TRANSMITTING AND/OR RETRIEVING REAL-TIME VIDEO AND AUDIO INFORMATION OVER PERFORMANCE-LIMITED TRANSMISSION SYSTEMS (57) Abstract <p>The architecture of numerous networks, including the Internet with its World Wide Web (WWW) browsers and servers, support full file transfer for document retrieval. In order for the WWW to support continuous media, it is necessary to transmit video and audio on demand and in real-time, as well as new protocols for real-time data. The invention extends the architecture of the WWW to encompass the dynamic, real-time information space of video and audio. The inventive method, called Vosaic, short for Video Mosaic, incorporates real-time video and audio into standard hypertext pages and which are displayed in place. Video and audio transfers occur in real-time; there is no file retrieval latency. The video and audio result in compelling Web pages. Real-time video and audio data can be effectively served over the present day Internet with the proper transmission protocol. The invention includes a real-time protocol, called a video datagram protocol (VDP), for handling real-time video over the WWW. VDP minimizes inter-frame jitter and dynamically adapts to the client CPU load and network congestion. The video server in accordance with the invention dynamically changes transfer protocols, adapting to the request stream. The invention also is applicable to other networks using Internet-type protocols such as TCP/IP, including local area networks, metropolitan area networks, and wide area networks.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LJ	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

**METHOD OF AND SYSTEM FOR TRANSMITTING AND/OR RETRIEVING
REAL-TIME VIDEO AND AUDIO INFORMATION
OVER PERFORMANCE-LIMITED TRANSMISSION SYSTEMS**

FIELD OF THE INVENTION

5 The present invention relates to a method of and system for transmitting
and/or retrieving real-time video and audio information. The inventive method
compensates for congested conditions and other performance limitations in a
transmission system over which the video information is being transmitted. More
particularly, the invention relates to a method of transmitting and/or retrieving real-
10 time video and audio information over the Internet, specifically the World Wide Web.

BACKGROUND OF THE INVENTION

 "Surfing the Web" has entered the common vocabulary relatively recently.
Individuals and businesses have come to use the Internet both for electronic mail (e-
mail) and for access to information, commonly over the World Wide Web (WWW, or
15 the Web). As modem speeds have increased, so has Web traffic.

 Web browsers, such as National Computer Security Association (NCSA)
Mosaic, allow users to access and retrieve documents on the Internet. These
documents most often are written in a language called HyperText Markup Language
(HTML). Traditional information systems design for World Wide Web clients and
20 servers has concentrated on document retrieval and the structuring of document-
based information, for example, through hierarchical menu systems as are used in
Gopher, or links in hypertext as in HTML.

 Current information systems architecture on the Web has been driven by the
static nature of document-based information. This architecture is reflected in the use

of the file transfer mode of document retrieval and the use of stream-based protocols, such as TCP. However, full file transfer and TCP are unsuitable for continuous media, such as video and audio, for reasons which will be discussed in greater detail below.

5 The easy-to-use, point-and-click user interfaces of WWW browsers, first popularized by Mosaic, have been the key to the widespread adoption of HTML and the World Wide Web by the entire Internet community. Although traditional WWW browsers perform commendably in the static information spaces of HTML documents, they are ill-suited for handling continuous media, such as real time audio
10 and video.

Earlier Web browsers, such as Mosaic, required a user to wait until a document had been retrieved completely before displaying the document on the screen. Even at the faster transfer speeds which have been become possible in recent years, the delay between retrieval request and display has been frustrating
15 for many users. Particularly in view of the astronomical increase in Internet traffic, during especially busy times, congestion over the Internet has negated at least some of the speed advantages users have obtained by getting faster modems.

Video and audio files tend to be much larger than document files in many instances. As a result, the delay involved in waiting for an entire file to download
20 before it is displayed is even greater for video and audio files than for document files. Again, during busy times, Internet congestion would make the delays intolerable. Even in networks which are separate from the Internet, transmission of sizable video and audio files can result in long waits for file transfer prior to display.

Multimedia browsers such as Mosaic have been excellent vehicles for browsing information spaces on the Internet that are made up of static data sets. Proof of this is seen in the phenomenal growth of the Web. However, attempts at the inclusion of video and audio in the current generation of multimedia browsers have been limited to transfer of pre-recorded and canned sequences that are retrieved as full files. While the file transfer paradigm is adequate in the arena of traditional information retrieval and navigation, it becomes cumbersome for real time data. The transfer times for video and audio files can be very large. Video and audio files now on the Web take minutes to hours to retrieve, thus severely limiting the inclusion of video and audio in current Web pages, because the latency required before playback begins can be unacceptably long. The file transfer method of browsing also assumes a fairly static and unchanging data set for which a single unidirectional transfer is adequate for browsing some piece of information. Real time sessions such as videoconferences, on the other hand, are not static. Sessions happen in real time and come and go over the course of minutes to days.

The Hypertext Transfer Protocol (HTTP) is the transfer protocol used between Web clients and servers for hypertext document service. The HTTP uses TCP as the primary protocol for reliable document transfer. TCP is unsuitable for real time audio and video for several reasons.

First, TCP imposes its own flow control and windowing schemes on the data stream. These mechanisms effectively destroy the temporal relations shared between video frames and audio packets.

Second, unlike static documents and text files, in which data loss can result in irretrievable corruption of the files, reliable message delivery is not required for video

and audio. Video and audio streams can tolerate frame losses. Losses are seldom fatal, although of course they can be detrimental to picture and sound quality. TCP retransmission, a technique which facilitates reliable document and text transfer, causes further jitter and skew internally between frames and externally between

1/28

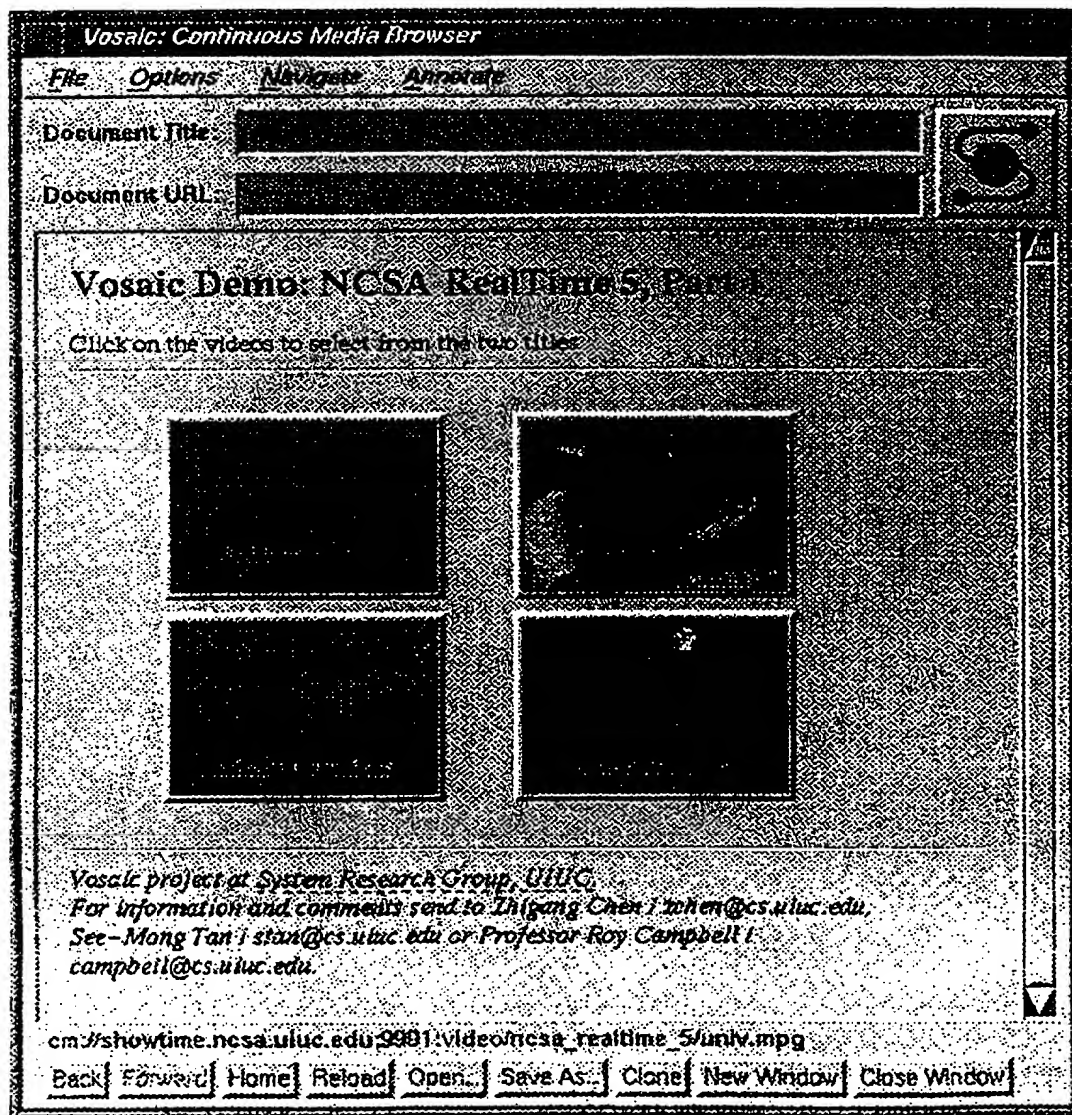
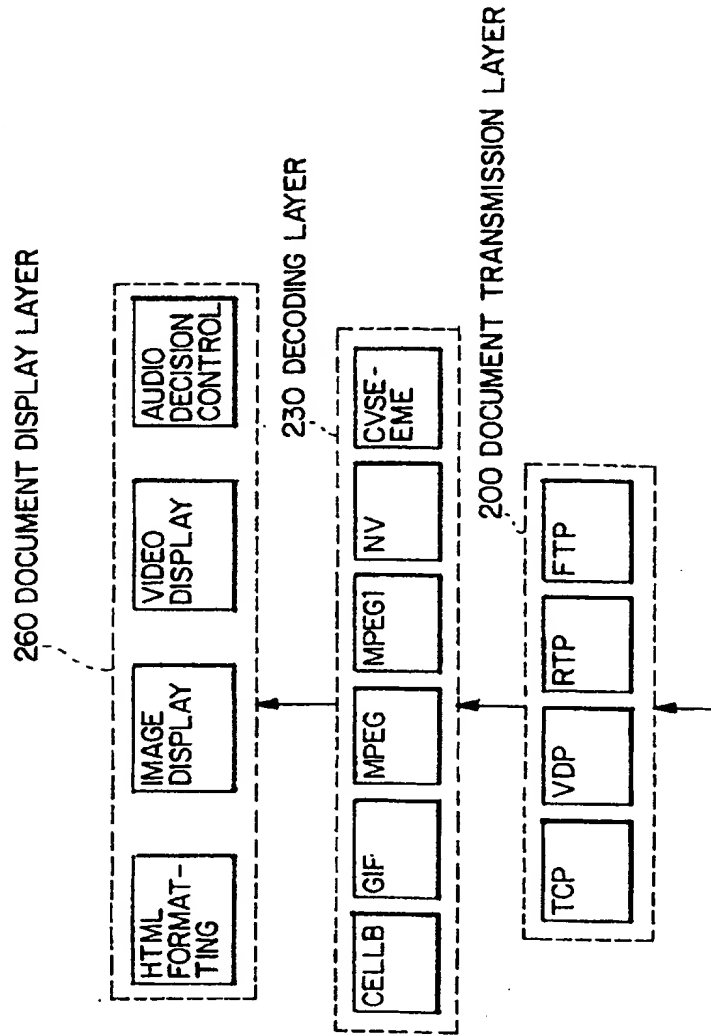


FIG. 1

FIG. 2



3/28

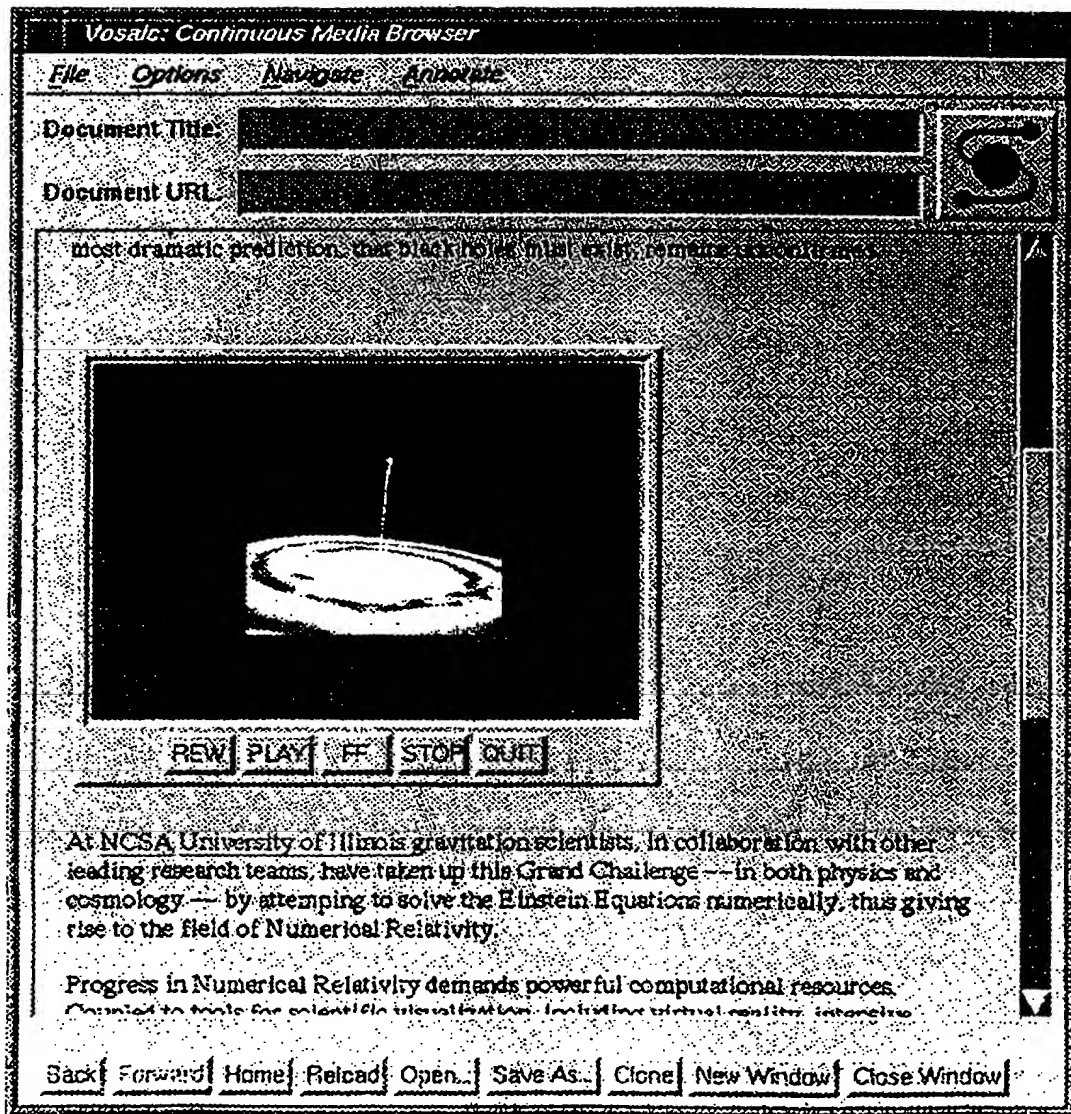


FIG.3

4/28

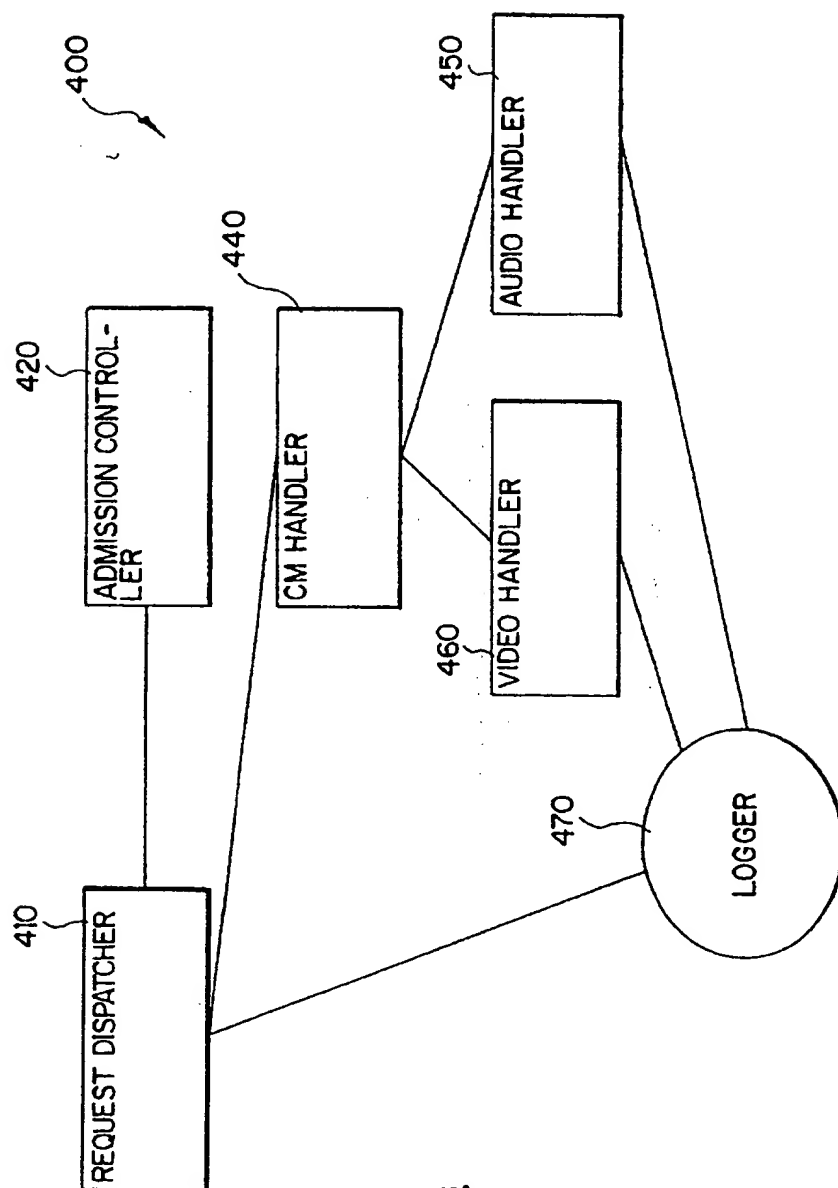


FIG. 4

5/28

FIG. 5

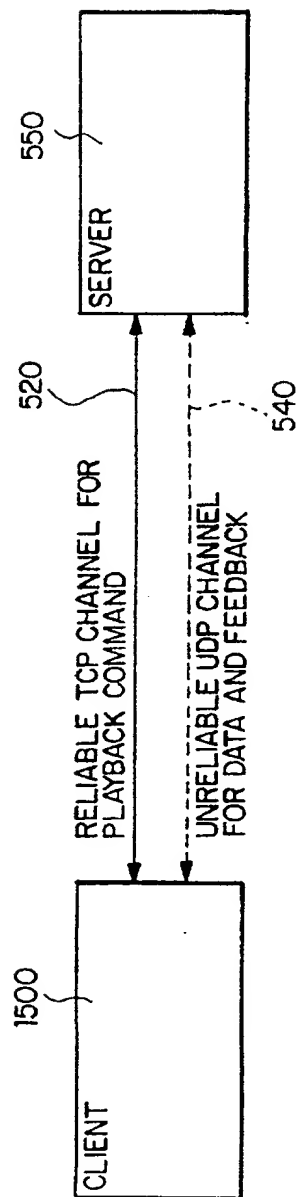
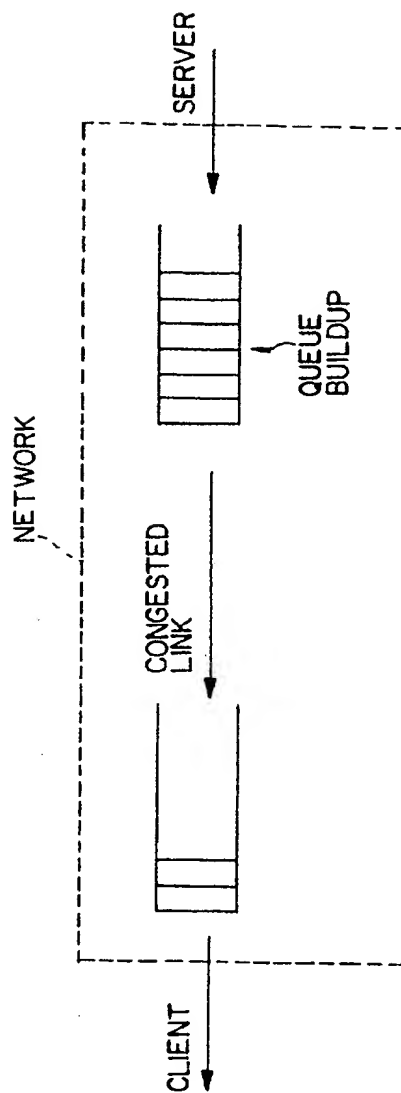
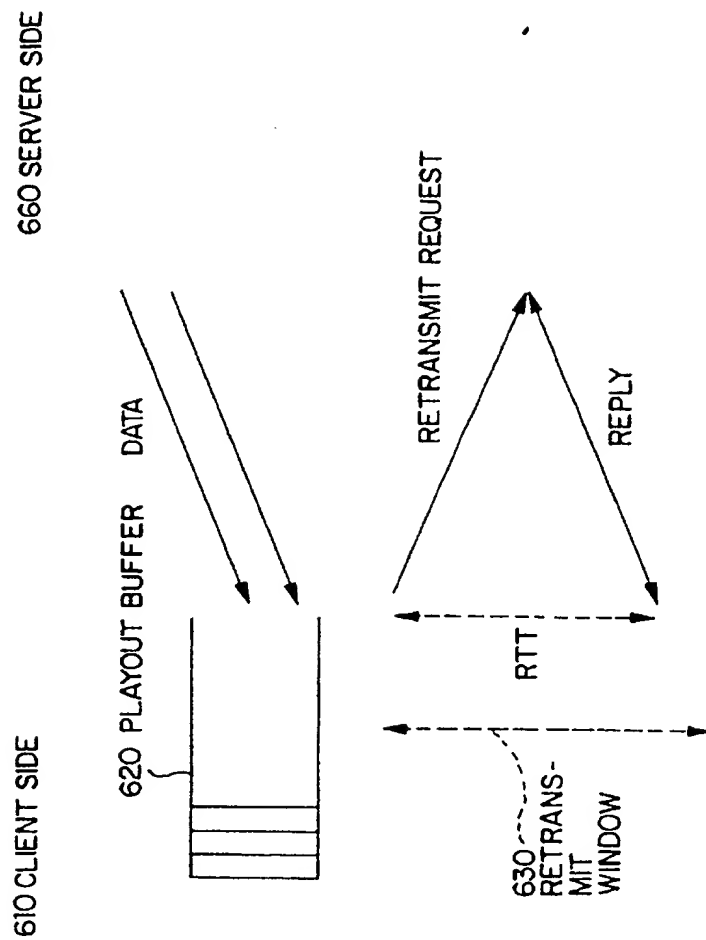


FIG. 7



6/28

FIG. 6



7/28

FIG. 8

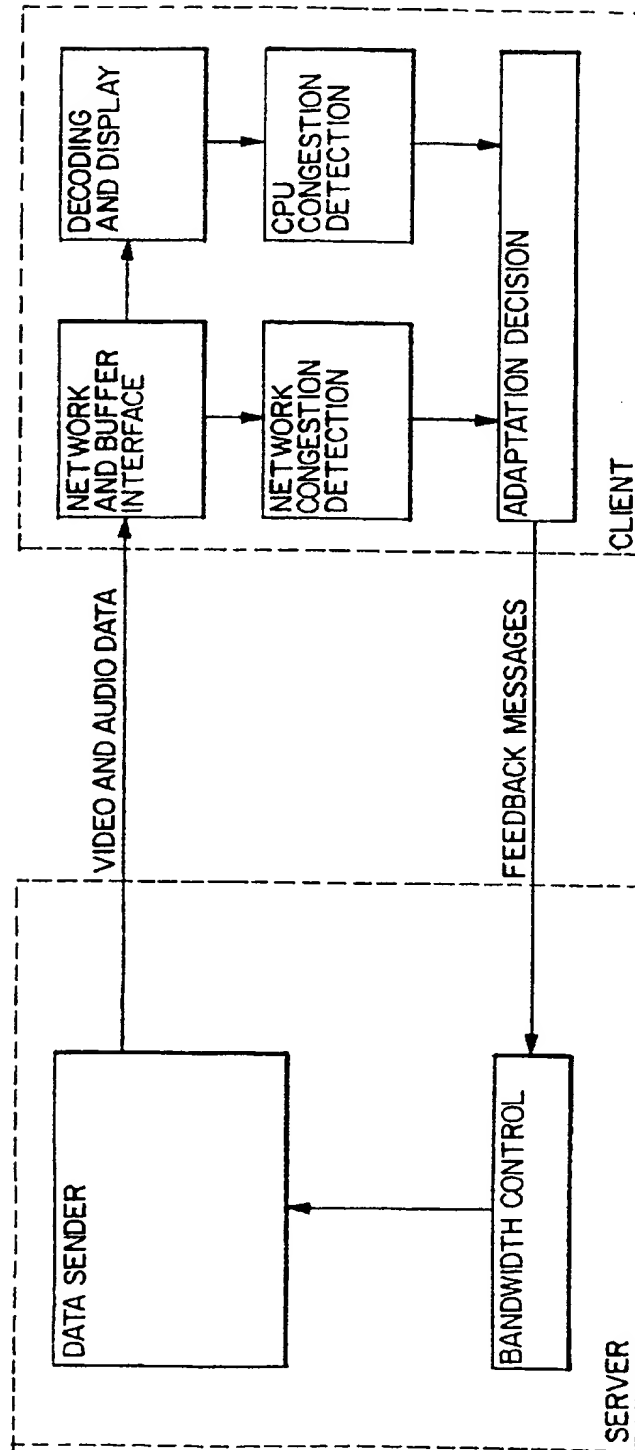


FIG. 9

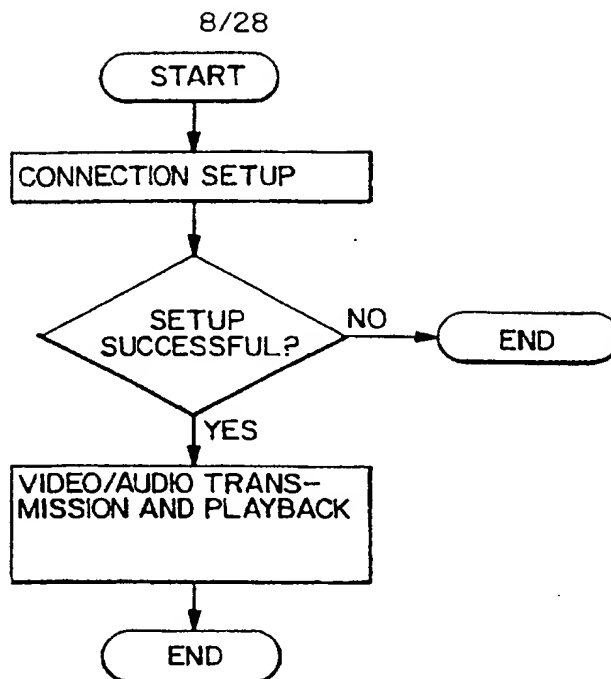
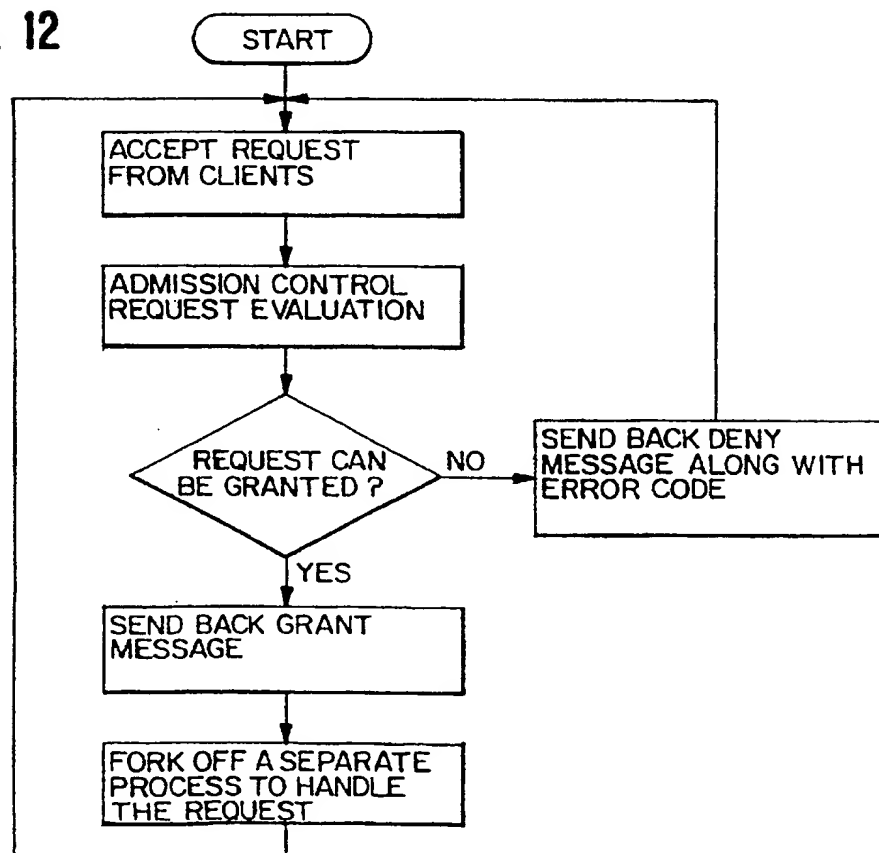
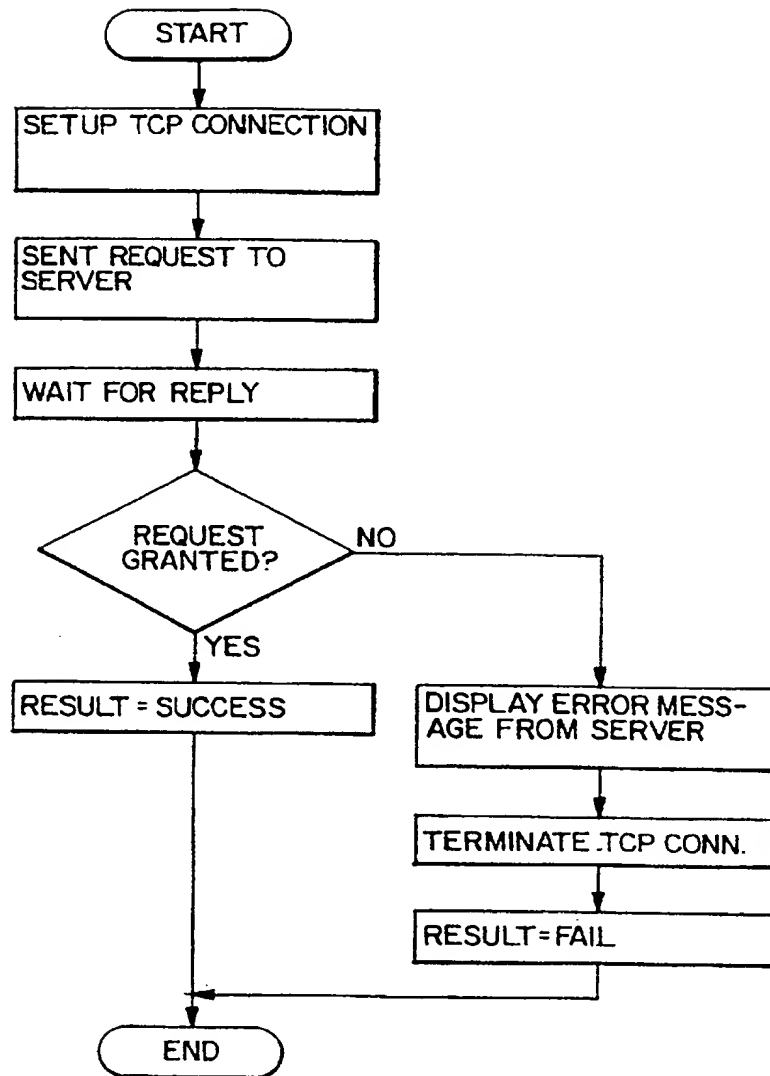


FIG. 12



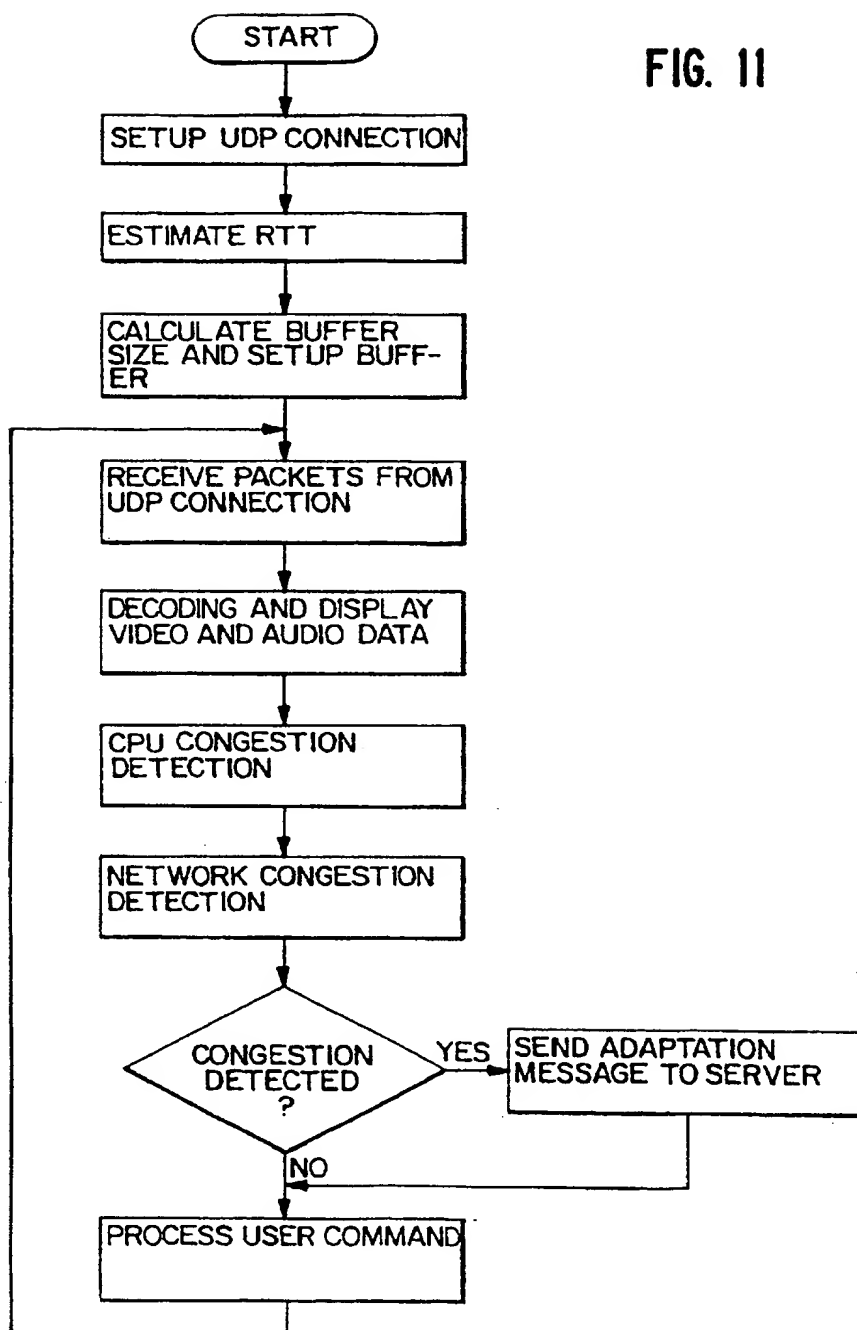
9/28

FIG. 10



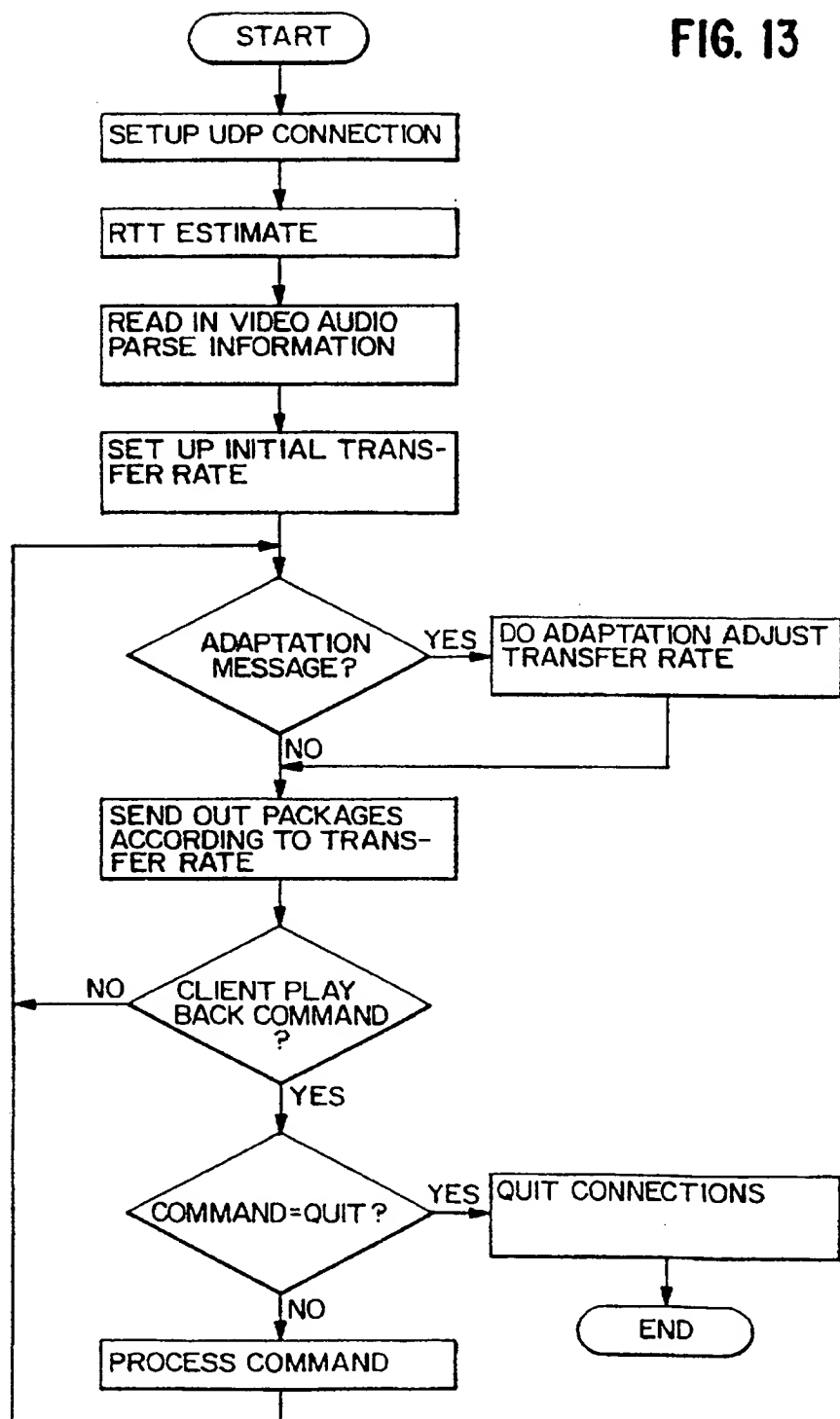
10/28

FIG. 11



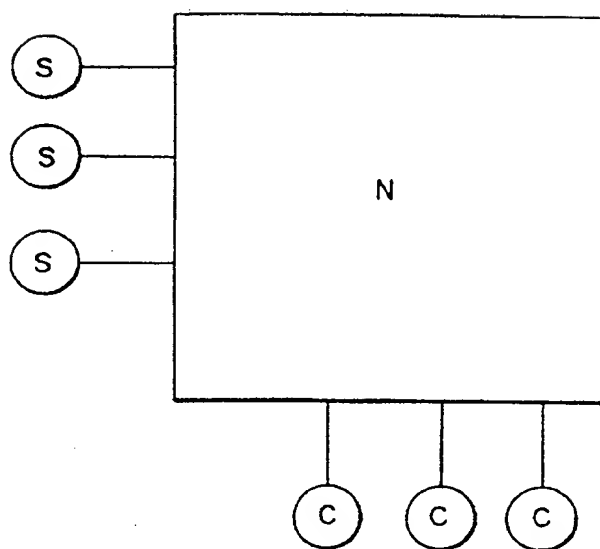
11/28

FIG. 13



12/28

FIG. 14



13/28

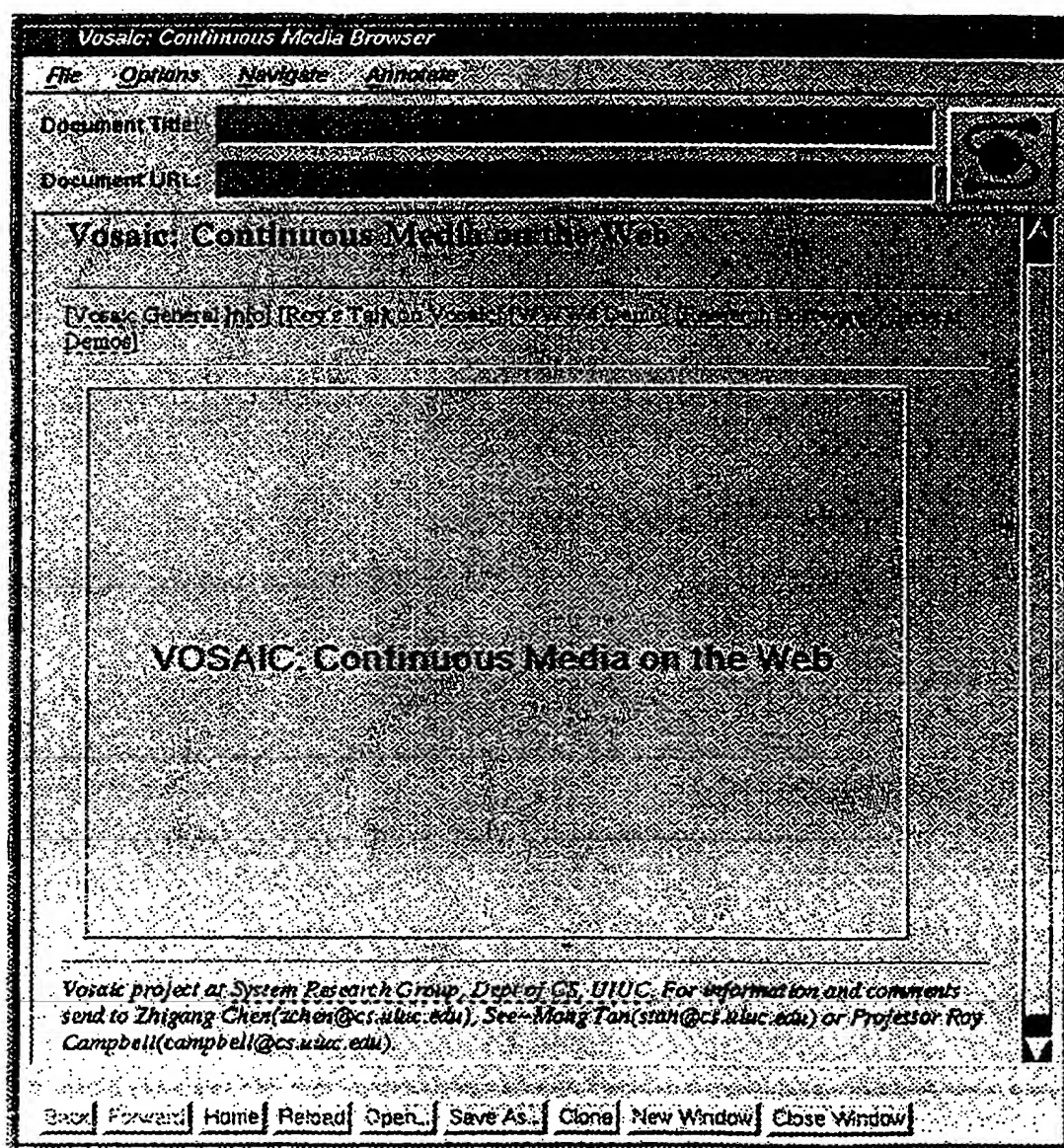


FIG. 15A

14/28

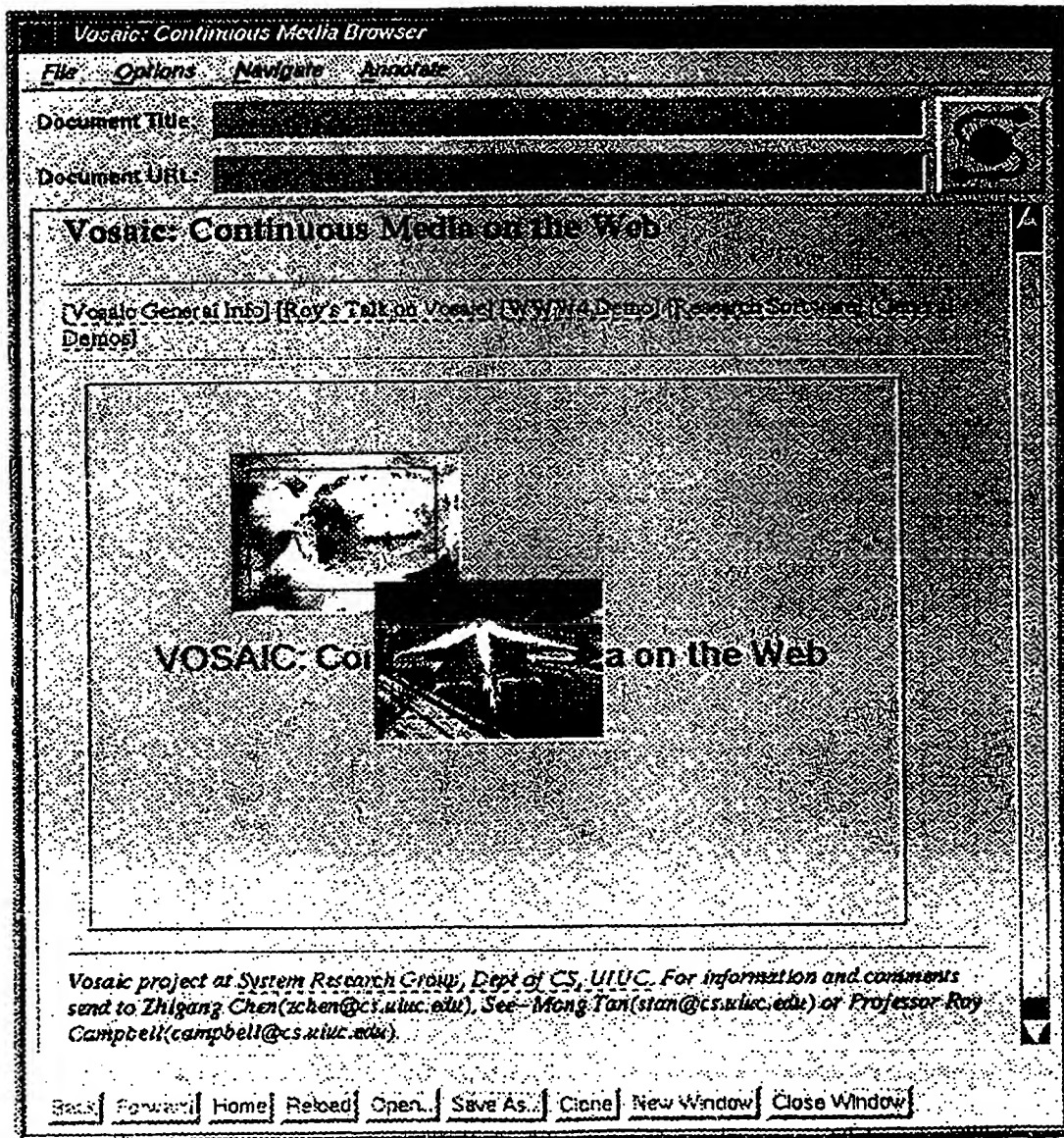


FIG. 15B

15/28

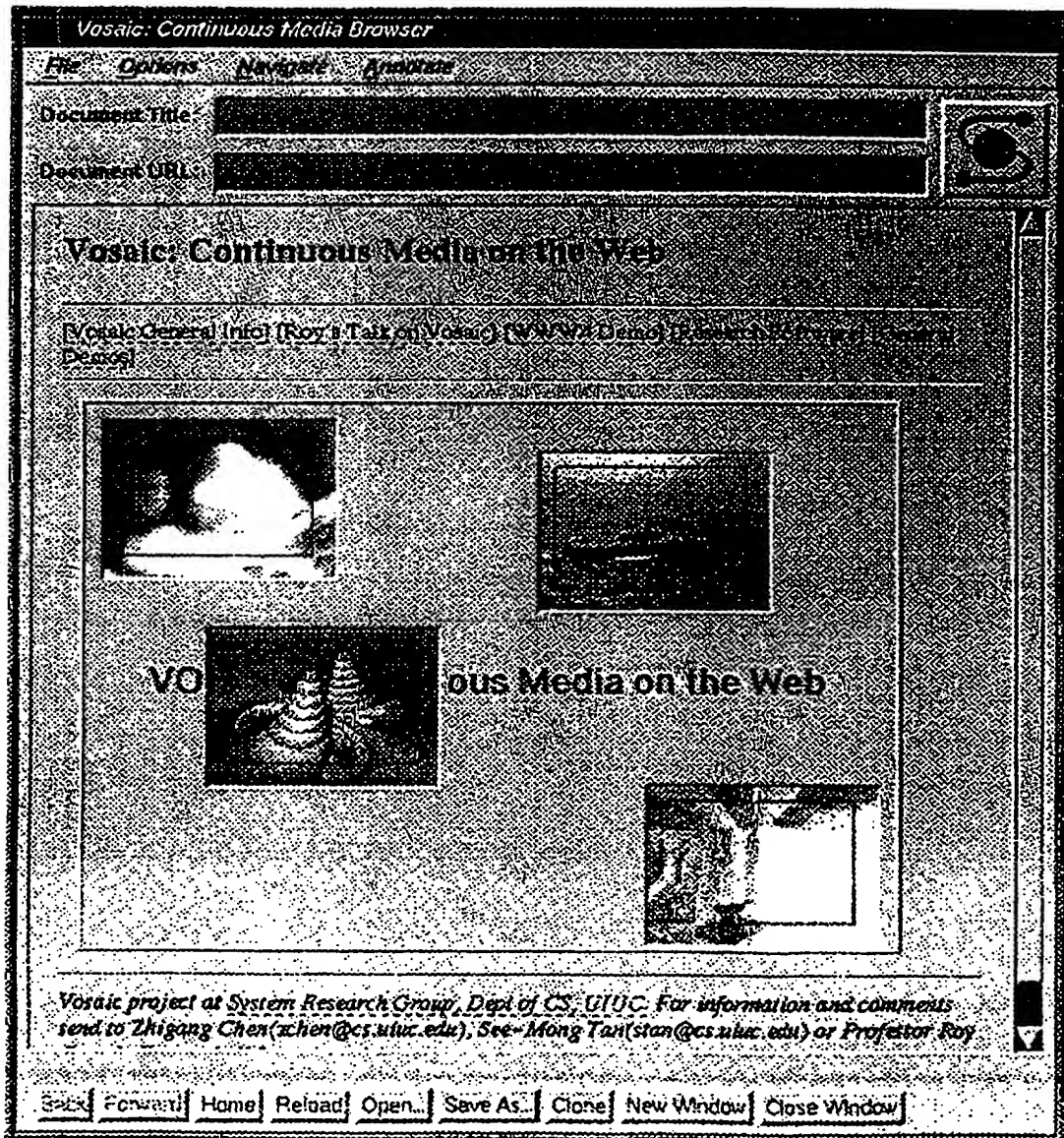


FIG. 15C

16/28

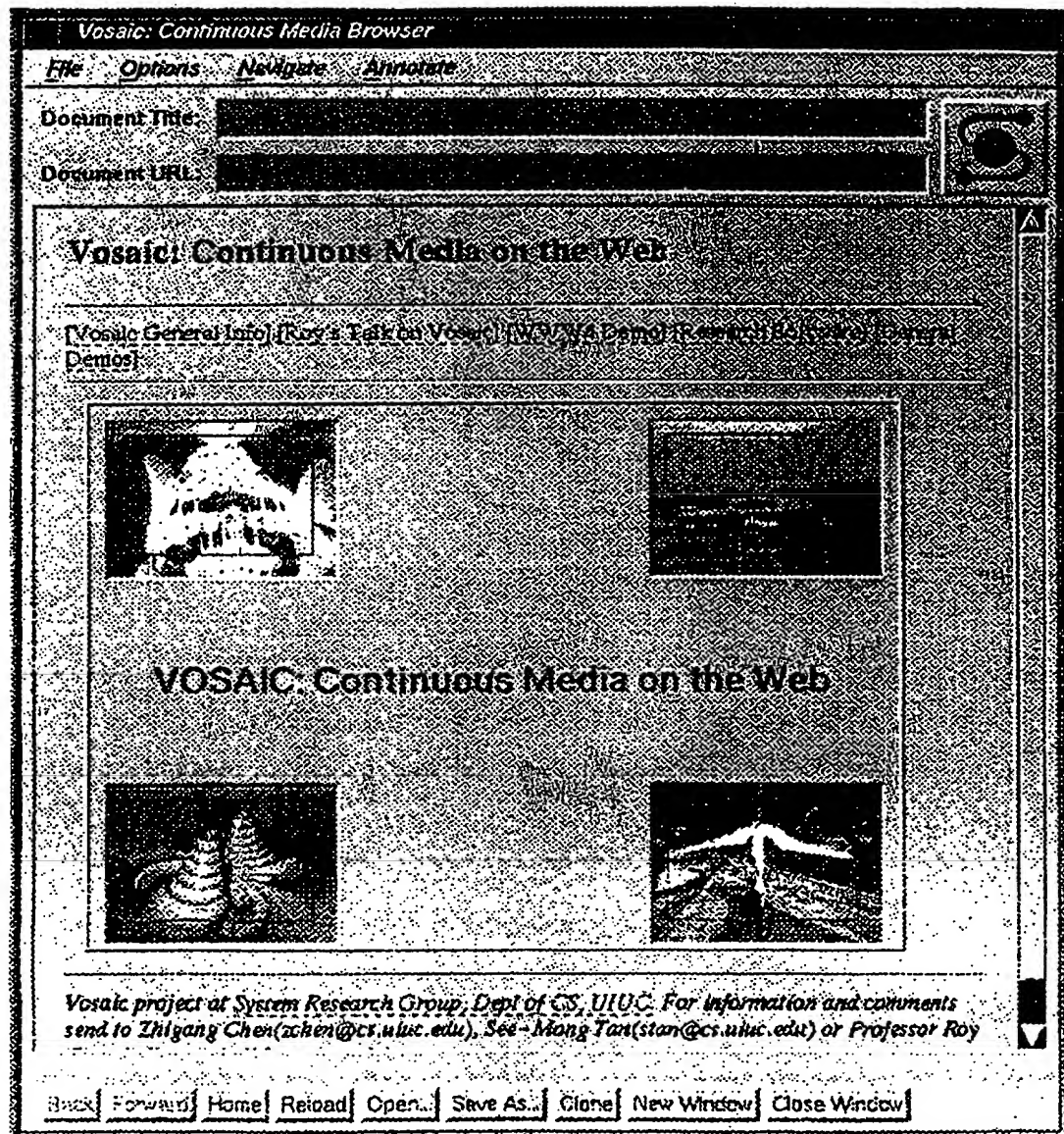


FIG. 15D

17/28

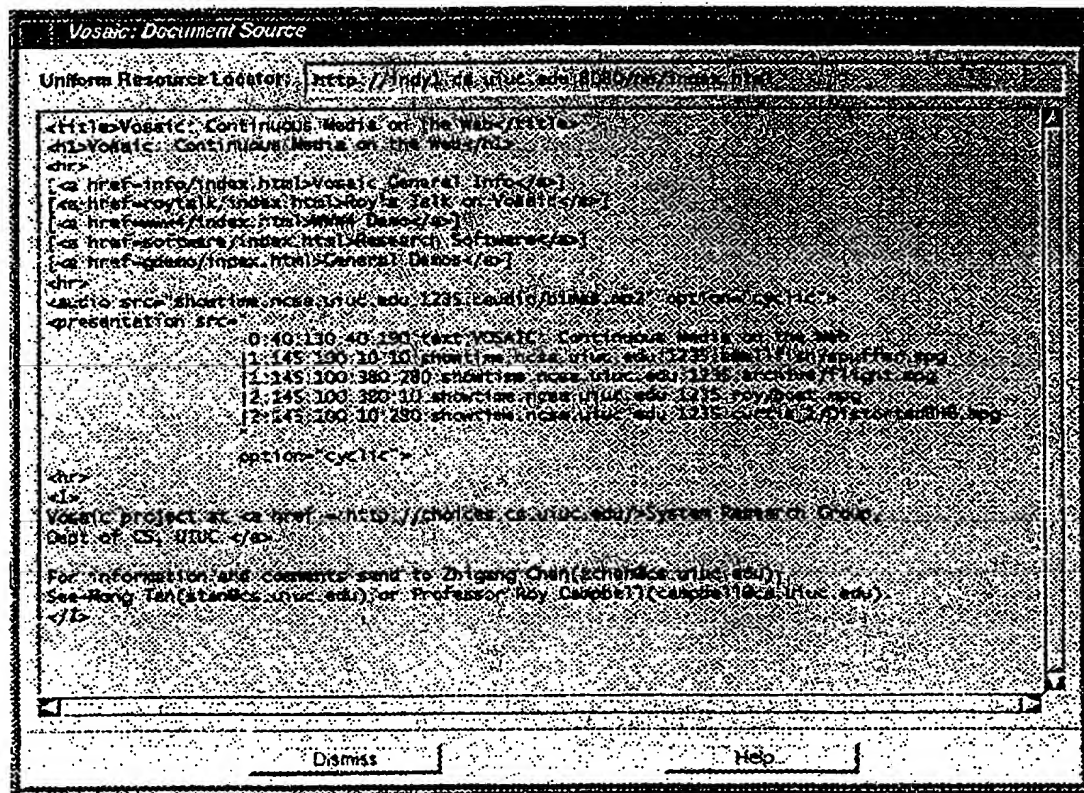


FIG. 15E

18/28

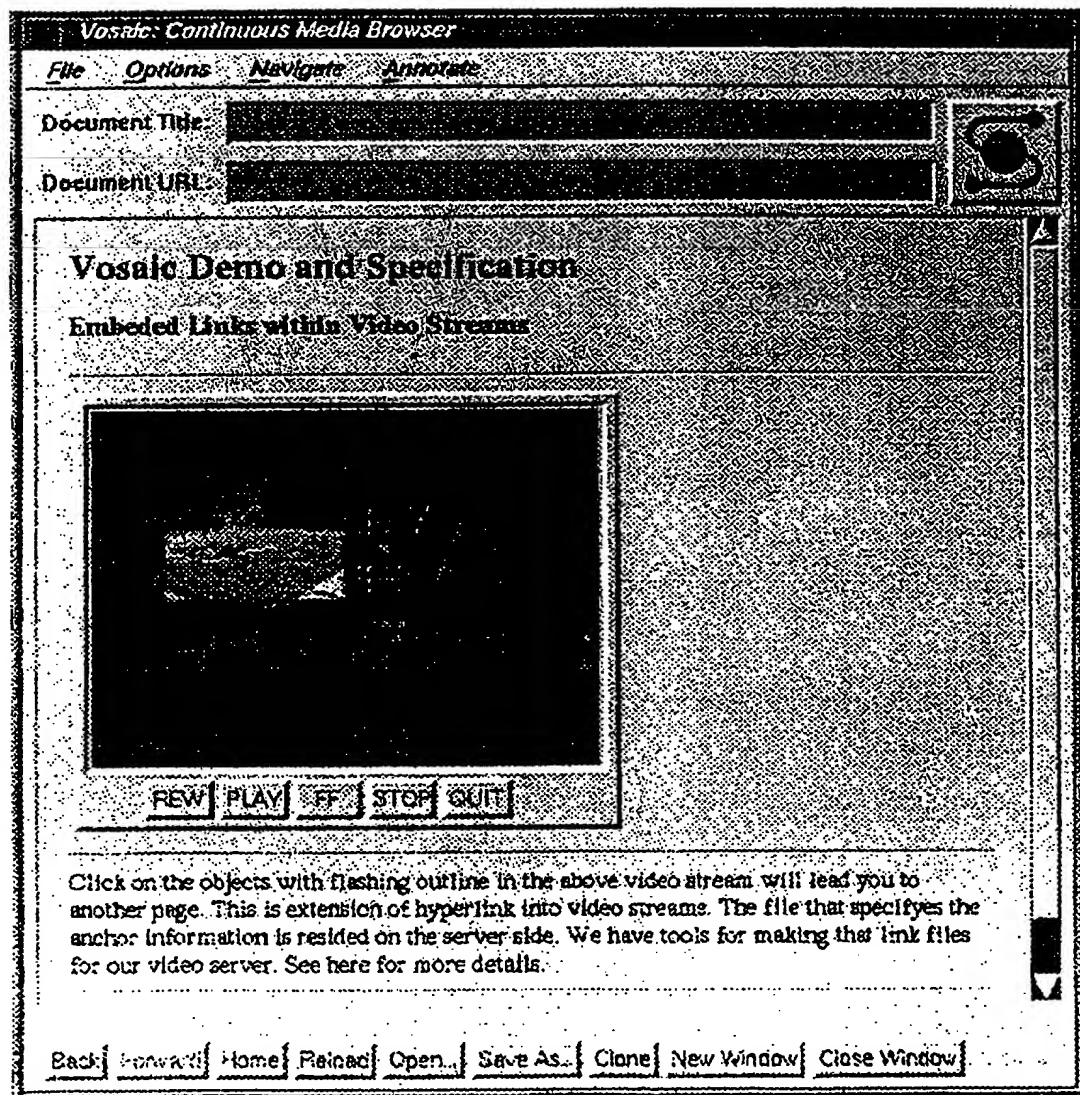


FIG. 15F

19/28

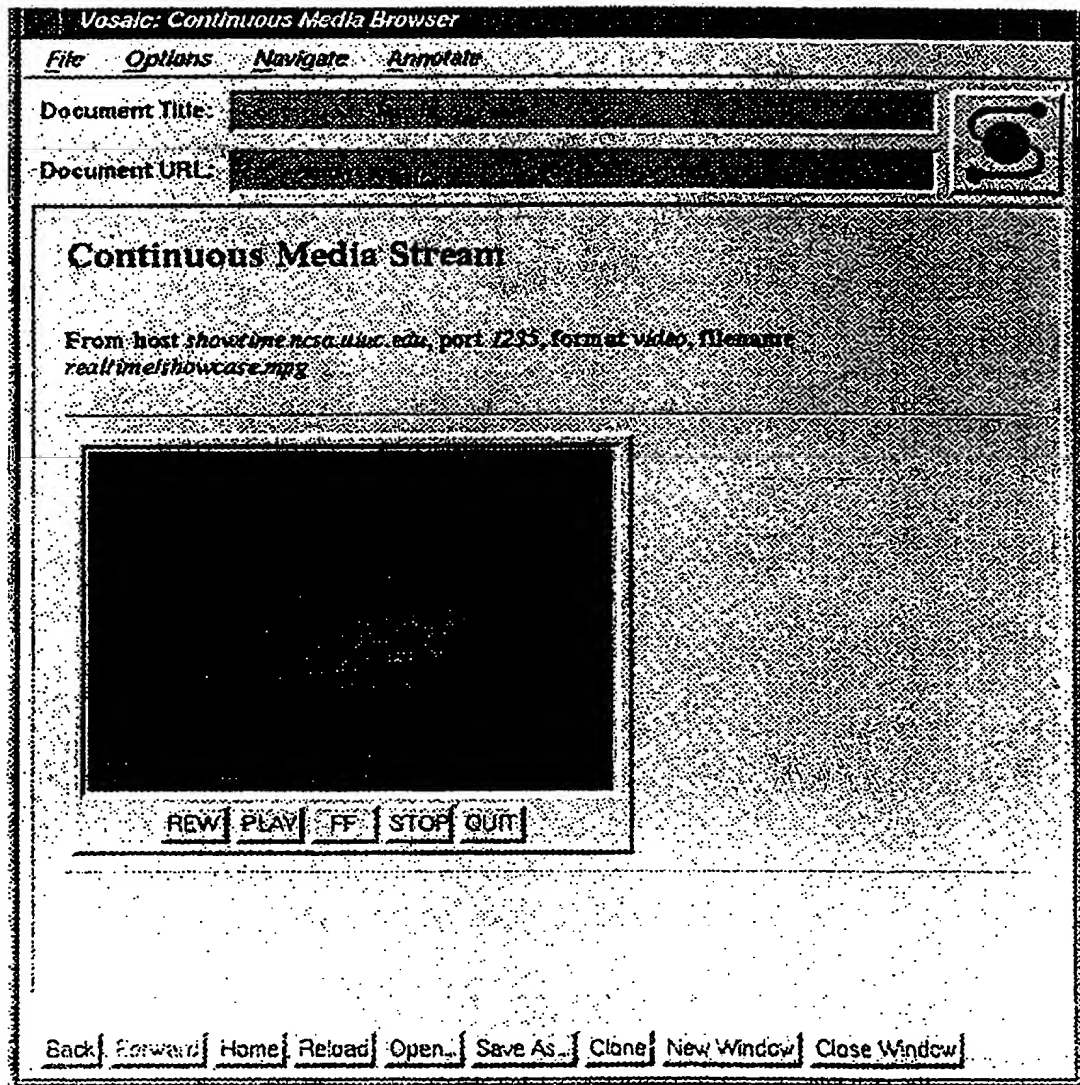
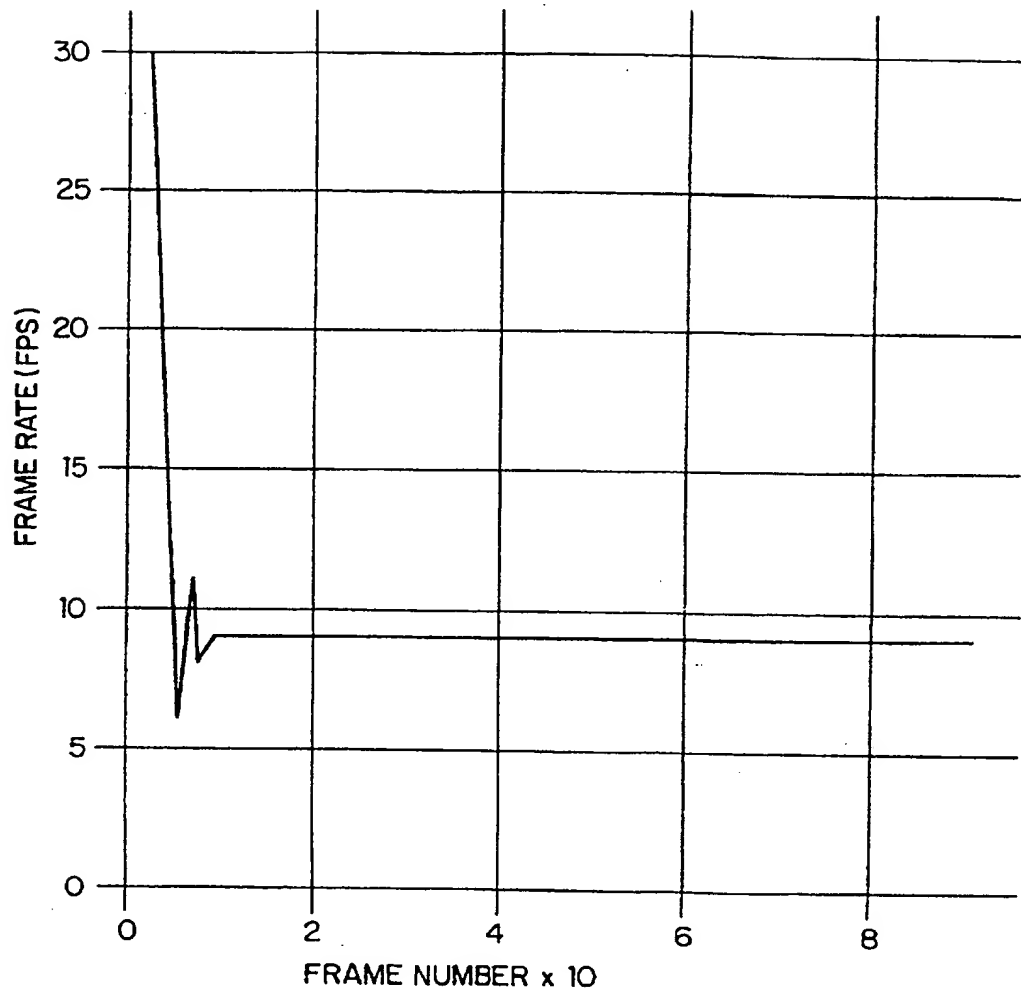


FIG. 15G

20/28

FIG. 16



SUBSTITUTE SHEET (RULE 26)

FIG. 17

SEMANTIC DESCRIPTION ANNOTATION 1	SEMANTIC DESCRIPTION ANNOTATION 2	...	SEMANTIC DESCRIPTION ANNOTATION n
INHERENT PROPERTIES		STRUCTURAL INFORMATION	
PHYSICAL REPRESENTATION			

22/28

FIG. 18

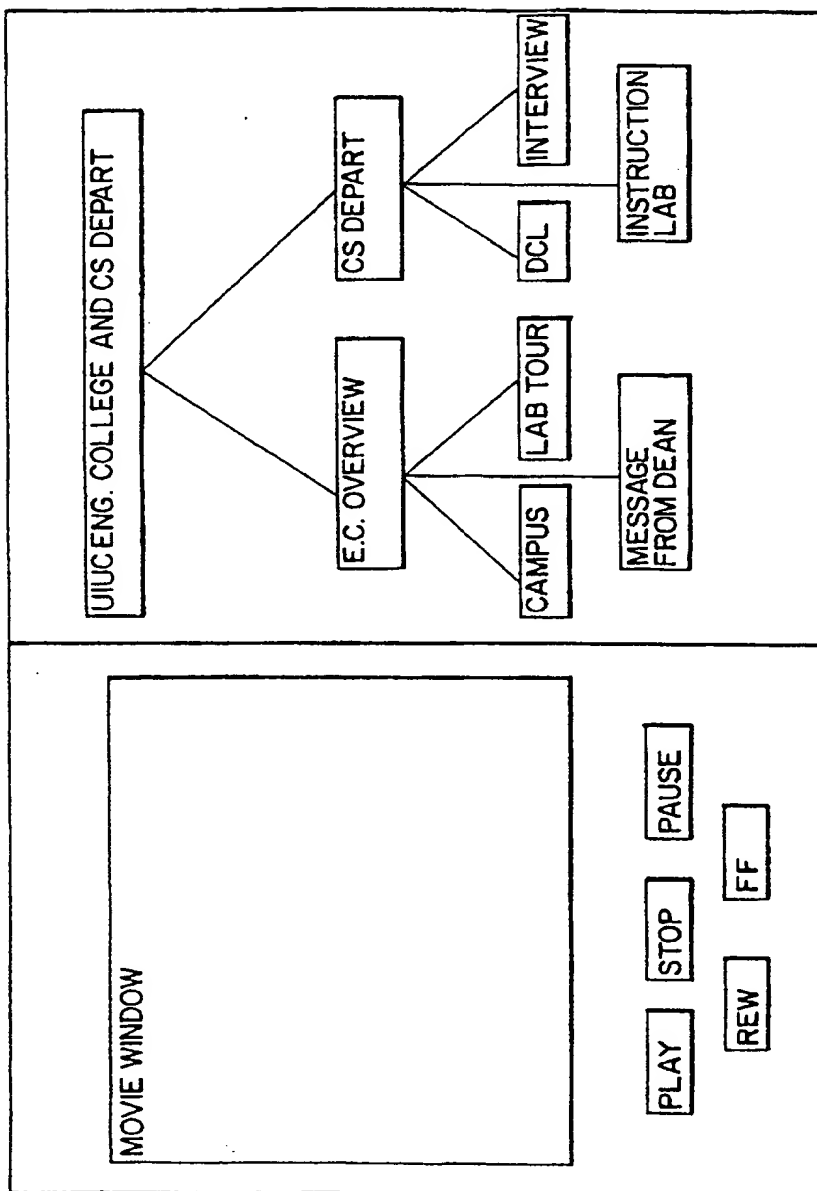
MOVIE: ENGINEERING COLLEGE AND CS DEPARTMENT AT UIUC	
CLIPS	SHOTS
ENGINEERING COLLEGE OVERVIEW (FRAMES 1-6355)	CAMPUS OVERVIEW (1-1203)
	MESSAGE FROM DEAN (1204-2566)
	ONE LAB TOUR (2567-4333)
	. . .
COMPUTER SCIENCE DEPARTMENT (FRAMES 6356 - 12003)	DCL TOUR AND OVERVIEW (6400-8000)
	INSTRUCTION LAB TOUR (8001- 9654)
	INTERVIEW WITH A UNDERGRADUATE STUDENT (9655-11000)
	. . .

23/28

FIG. 19

SHOTS	FRAMES	KEY WORDS
CAMPUS OVERVIEW	1-1203	UIUC, ENGINEERING CAMPUS, CAMPUS
MESSAGE FROM DEAN	1204-2566	UIUC, ENGINEERING, DEAN, TALK
ONE LAB TOUR	2567-4333	UIUC, ENGINEERING, LAB TOUR
DCL TOUR AND OVERVIEW	6400-8000	UIUC, CS DEPART, DCL, TOUR, OVERVIEW
INSTRUCTIONAL LAB TOUR	8001-9654	UIUC, CS DEPART, TOUR, INSTRUCTIONAL LAB
INTERVIEW WITH A UNDERGRADUATE STUDENT	9655-11000	UIUC, CS DEPART, INTERVIEW

FIG. 20



25/28

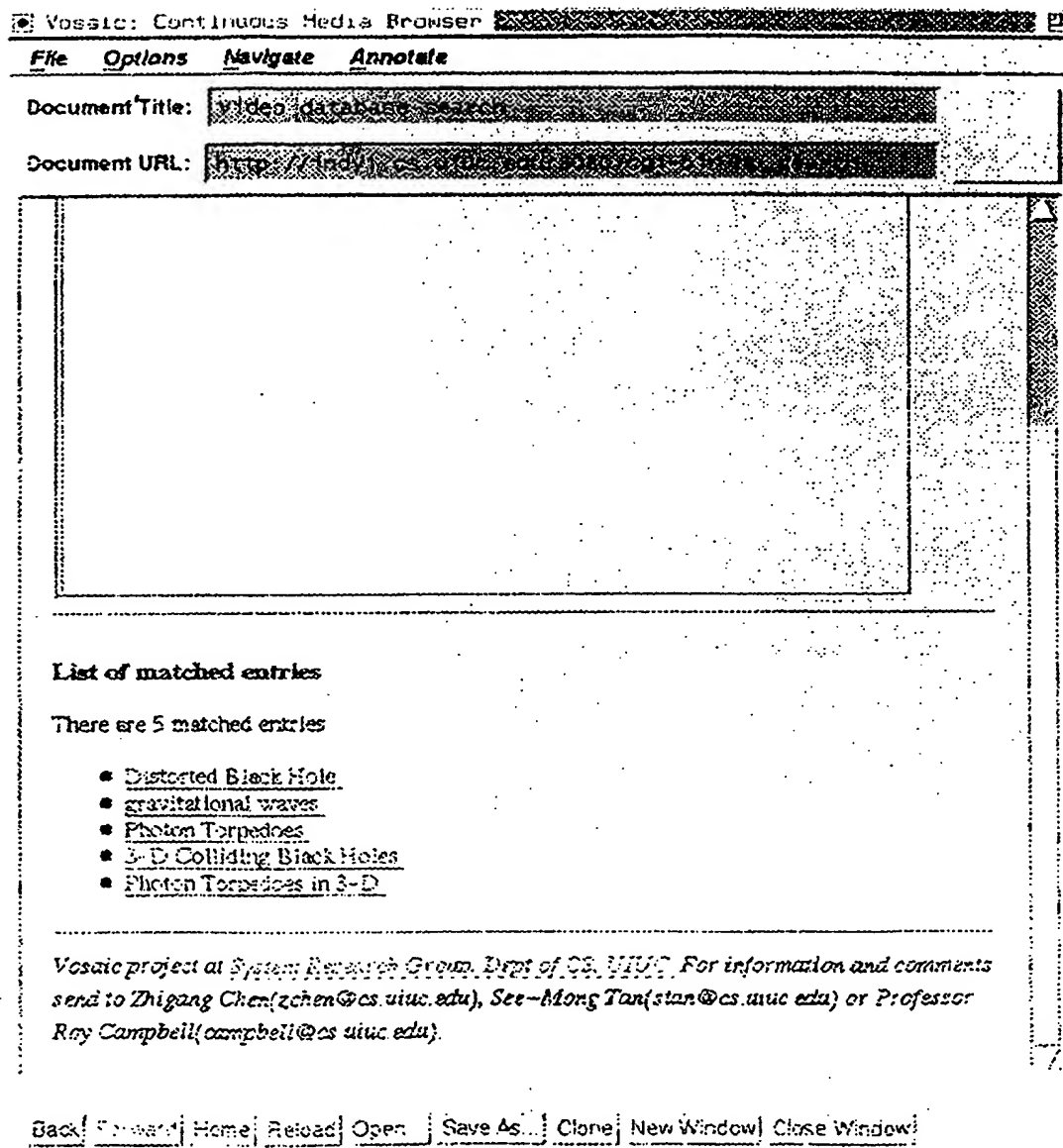


FIG. 21

26/28

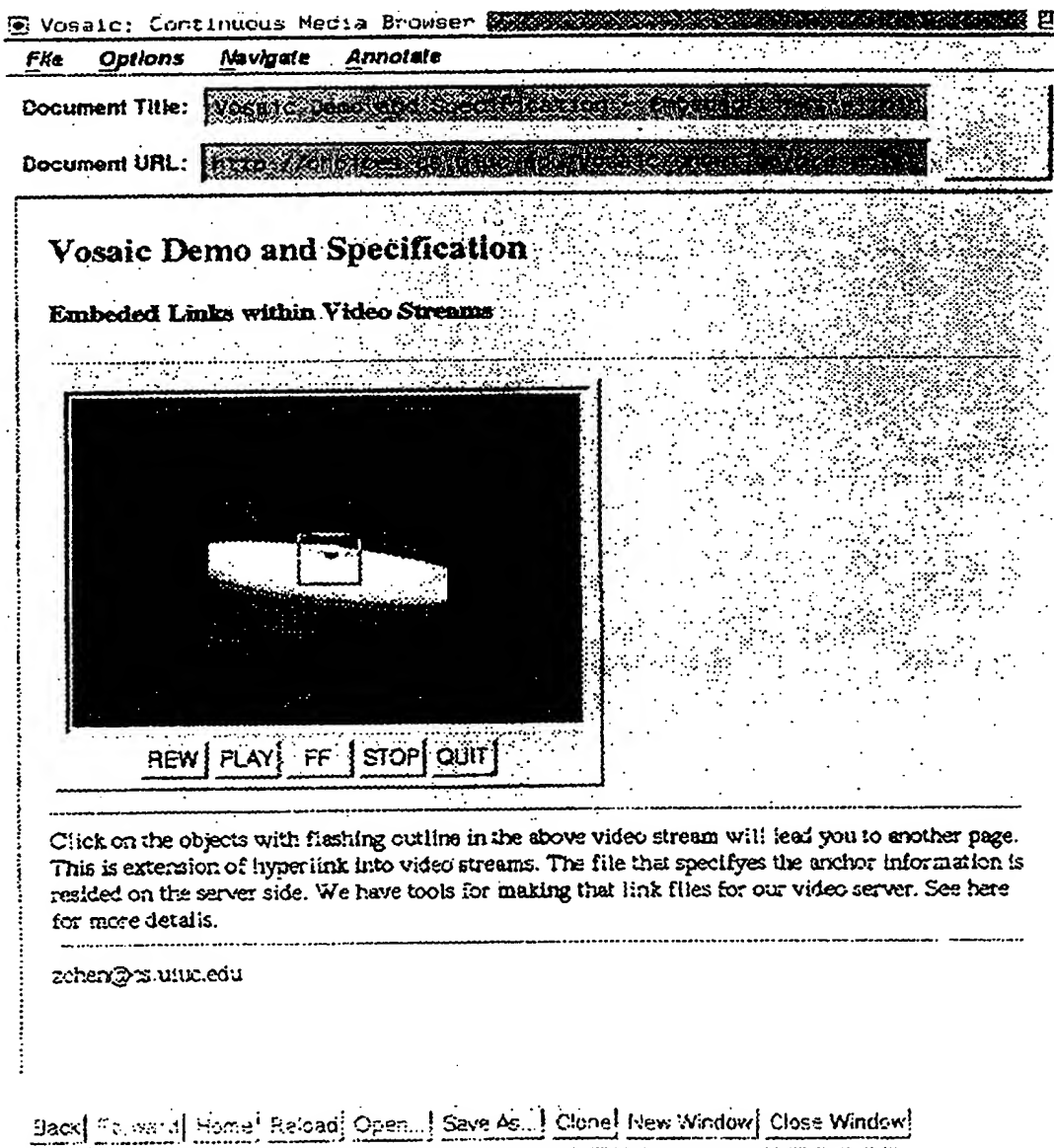


FIG. 22

SUBSTITUTE SHEET (RULE 26)

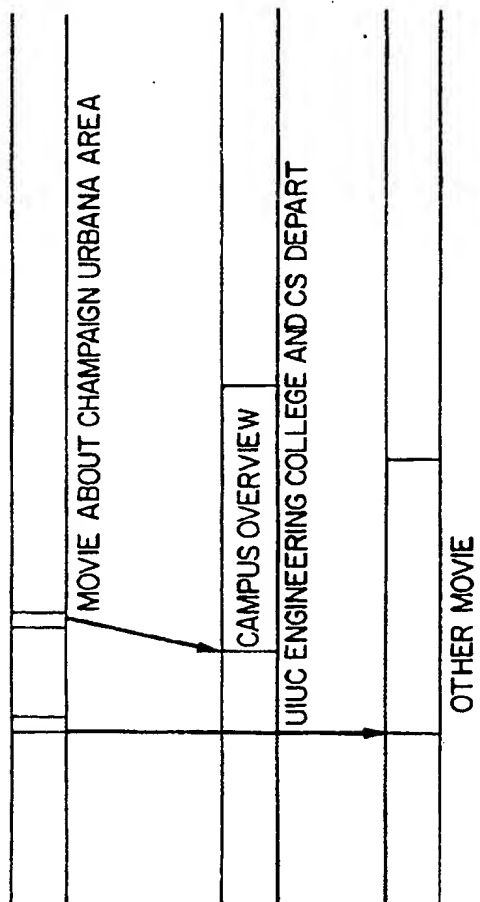


FIG. 23

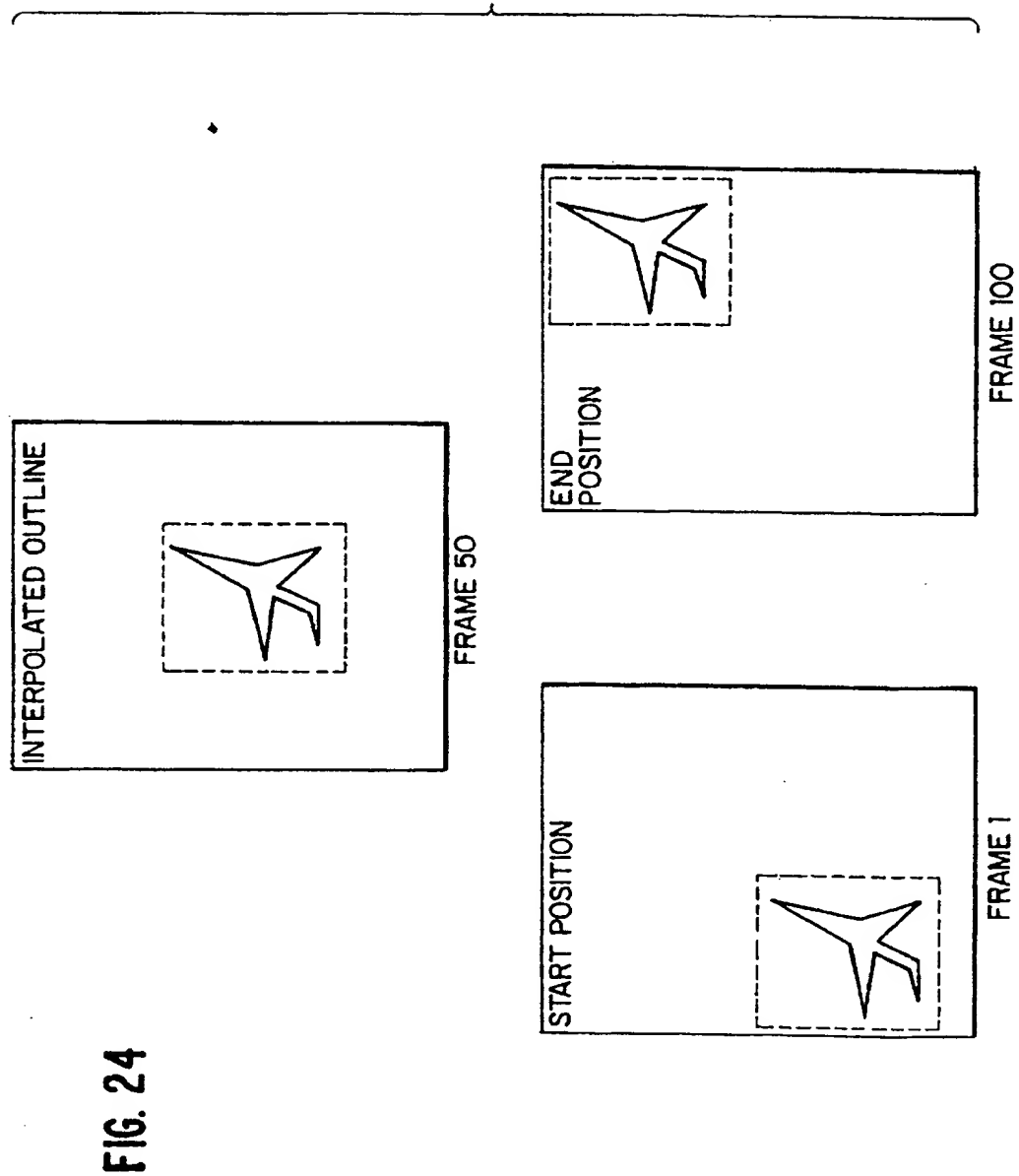


FIG. 24